HSLU Hochschule Luzern

Technik & Architektur
BSc. Wirtschaftsingenieurwesen | Innovation
Bachelor-Thesis

Thermodynamic and kinetic study of di-sodium hydrogen phosphate hydrates for latent heat storage

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1. Hintergrund, Forschungsfragen & Zielsetzungen

Addressing the global energy crisis demands innovative, sustainable solutions. Our research focuses on harnessing latent heat storage (LHS) using Phase Change Materials (PCMs), specifically Di-sodium hydrogen phosphate dodecahydrate (DSPD). However, understanding DSPD's thermodynamics and kinetics presents certain challenges. Our project aims to:

- Investigate the properties of DSPD through comprehensive literature review.
- Study the effects of sample preparation using ThermoGravimetric Analysis-Differential Scanning Calorimetry (TGA-DSC).
- Identify different DSP hydrates via DSC and moisture analysis.
- Ensure reliable findings through repetition of tests.

Our objective is to shed light on the mysteries of DSPD to fully exploit its potential in sustainable energy storage solutions.

2. Methoden / Material

To gain insights into the dynamics of DSPD, we implemented a three-pronged approach, encompassing Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), and room temperature measurements.

Through TGA, we heated DSP samples from 40°C to 200°C, tracking the associated mass loss due to water release. This process helped differentiate between DSPD's hydrate forms. DSC, measuring the heat flow tied to phase transitions over time and temperature, was executed over two heating and cooling cycles of the samples. This yielded data on the enthalpy of fusion and precise melting temperatures, critical for identifying specific hydrate forms and illuminating the DSPD's thermodynamics and kinetics.

Supplementing these techniques, we conducted room temperature experiments, monitoring DSP sample mass loss at 54-minute intervals, adding valuable insights into the hydrate forms' stability under ambient conditions.

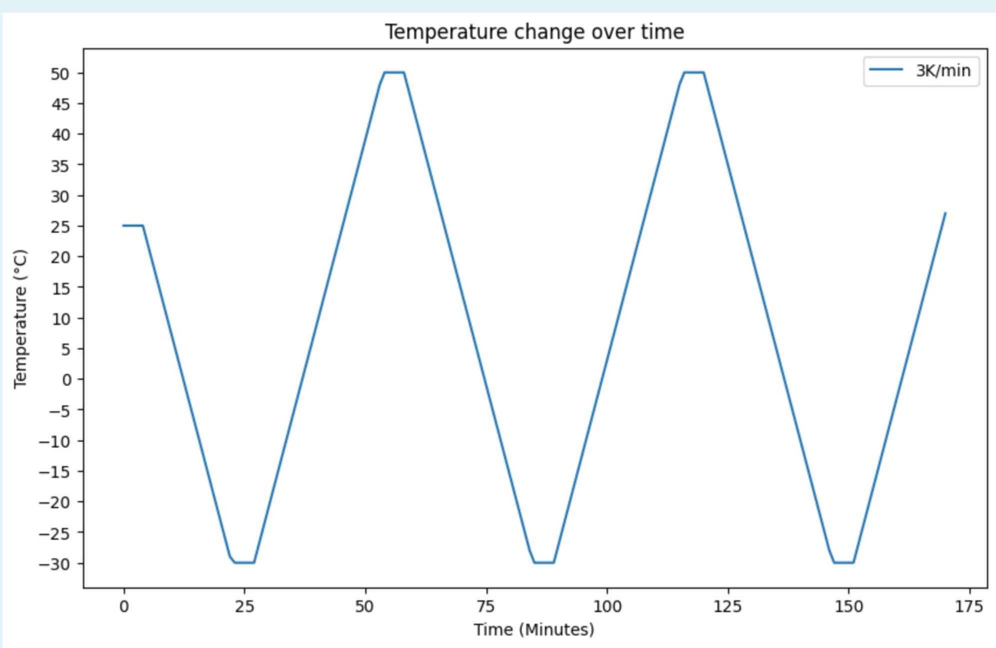
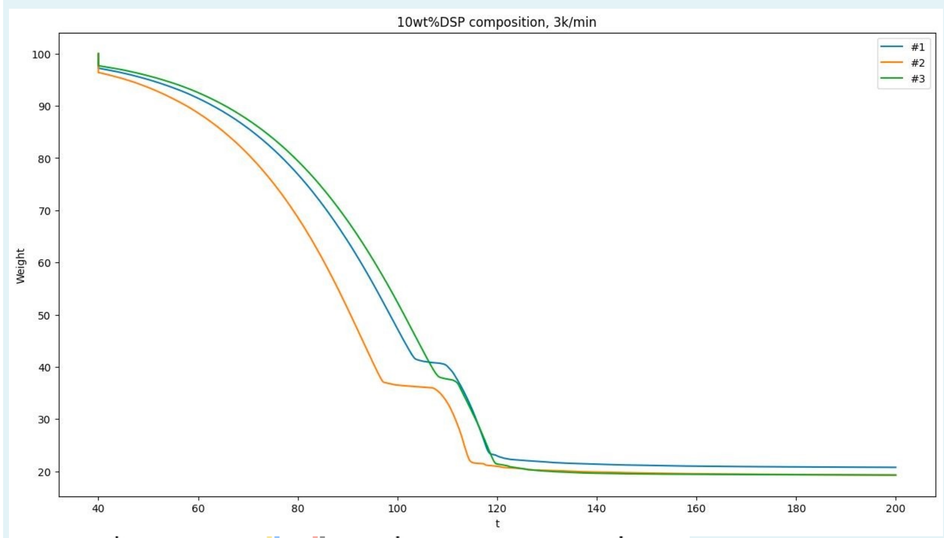


Figure 1: depicts the method employed for Differential Scanning Calorimetry (DSC) analysis. The temperature range for this particular experiment spans from -30 to 50 degrees Celsius.

3. Resultate / Lösungen / Empfehlungen

Batch5 , 24.10, 39.90%RH	sample A	sample B	sample C
Initial	44.84	49.45	48.986
5 min	42.144	47.634	44.821
10min	41.108	46.601	43.798
15min	40.17	45.673	42.862



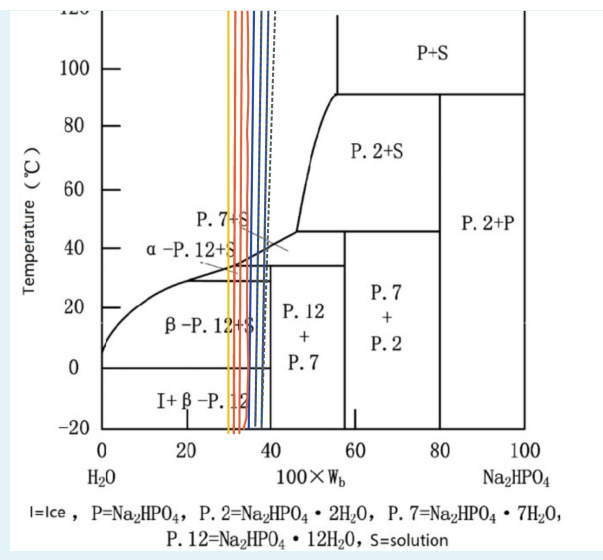


Figure 2:The results of a room temperature experiment that involved measuring the mass lost and its relationship with a phase diagram

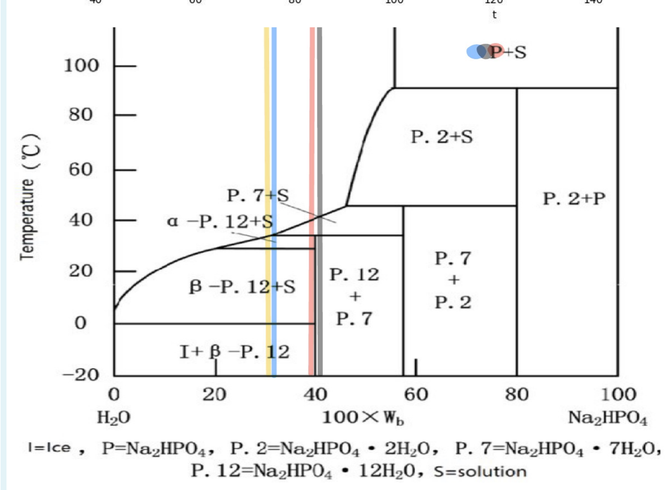
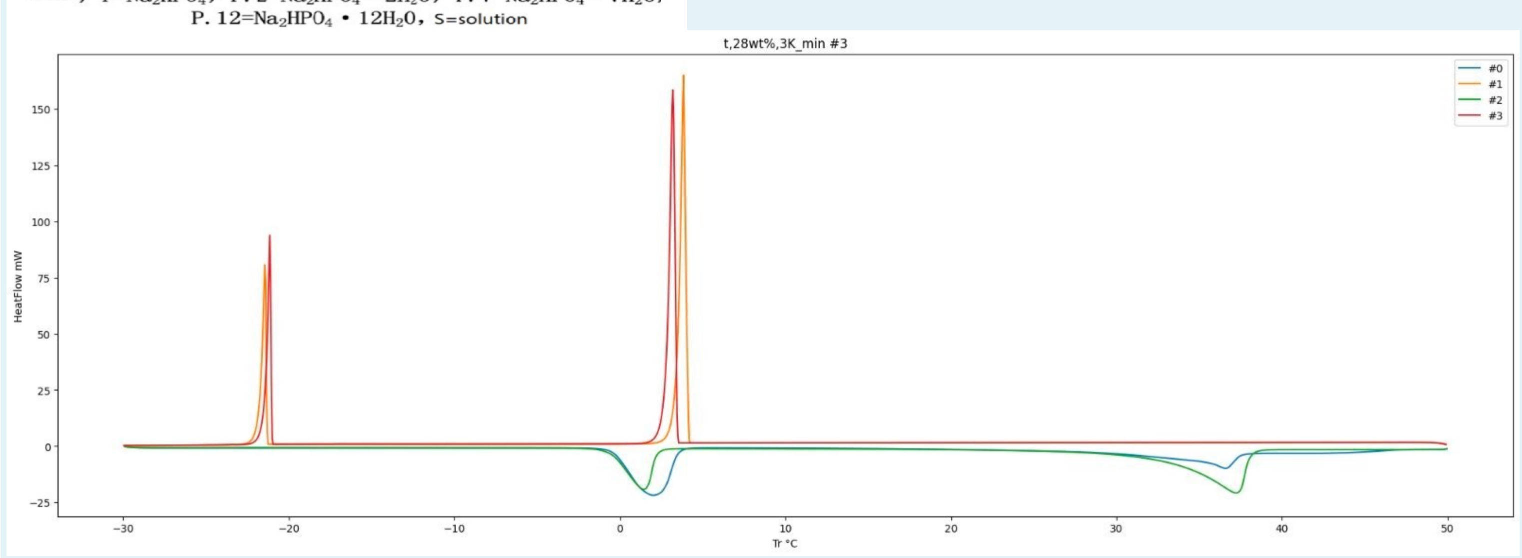


Figure 3: Results from the Tag method displayed on a phase diagram.

Figure4: the DSC(Differential Scanning Calorimetry) result, indicating a melting temperature of 34 degrees Celsius and an enthalpy of fusion of 153 J/g.



4. Diskussion, Schlussfolgerung & Ausblick

The results obtained present some notable discrepancies. The recorded enthalpy of fusion does not match previous published values.

Similarly, the sample's behavior at room temperature and during TGA analysis indicates a lack of stability in its composition. This continuous change, seen as a loss of water content and a shift towards the right side of the phase diagram, isn't supported by existing phase diagram predictions. This finding accentuates the need for more comprehensive research to fully understand the intricacies of DSP and its hydrates under varying conditions.

Literatur

Solid–Liquid Phase,Change Materials for Energy Storage Opportunities and Challenges,A. Stamatiou, S. Maranda, L. J. Fischer, and J. Worlitschek Lucerne University of Applied Sciences and Arts

Kenisarin, M., & Mahkamov, K. (2016). Salt hydrates as latent heat storage materials:Thermophysical properties and costs. Solar Energy Materials and Solar Cells, 145, 255–286. https://doi.org/10.1016/j.solmat.2015.10.029(Kenisarin & Mahkamov, 2016)

FH Zentralschweiz

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